

Comparison of condensation particle counters (CPCs) intended for workplace measurements

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The use of CPCs under several conditions was subject to comparison tests in the frame of the mandate M/461 from the European Commission for the support of regulation in nanotechnology. In total 35 CPC instruments (12 different types, handheld and stationary, alcohol and water based, TSI and Grimm) from 10 partners with intended use in workplace exposure measurements had been compared. In the Nano Test Center of the IGF in Dortmund 28 different test aerosols were generated by a flame generator (NaCl, ZnO), spark generator (Cu, C) and a droplet generator/atomizer (DEHS, NaCl). A wide range of concentrations (14 000 to 760 000 cm⁻³) and particle mobility diameters (5 to 260 nm) was supplied for the instruments that were located in a chamber of 3x3x2.5 m³ over a period of 30 minutes for each aerosol. Questions of dependency from concentration, particle diameter, chemical composition, resp. hygroscopicity, and particle morphology in comparison with the statements of the manufacturers were in the focus of interest.

Deviations up to approximately 30 % from a reference seem to be reasonable in the specified operational range of the instruments. A missing calibration may contribute to larger discrepancies. Handheld CPCs TSI 3007 stay well below 35 % deviation from a reference CPC (TSI 3776, butanol, reliably calibrated) in their expected range of application (Fig. 1). For very small particles below approximately 20 nm and concentrations considerably exceeding 100 000 cm⁻³ a use is not recommended.

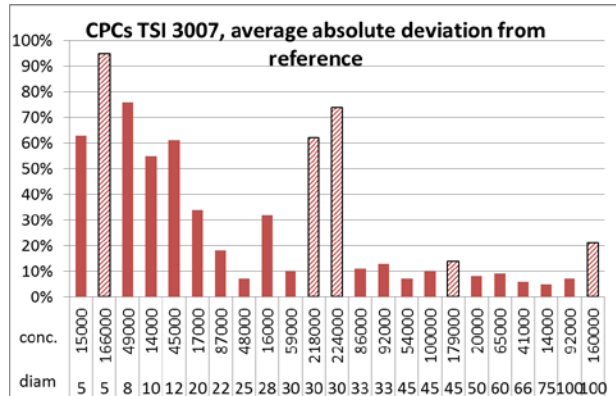


Figure 1. Handheld CPC TSI 3007, average deviation of 11 specimens from reference in dependence of concentration and particle diameter, dashed bars: >100 000 cm⁻³

TSI P-Trak instruments (7 specimens) counted in all

cases lower concentrations than the CPC 3007, i.e. higher deviations from the reference.

Stationary CPCs, investigated with 9 different types, show lower deviations (Fig. 2), mainly below 20 %. Attention must be paid for very small particles around 5 nm at high concentrations (like 166 000 cm⁻³). Approximately 30 % deviation was reached at concentrations above 160 000 cm⁻³.

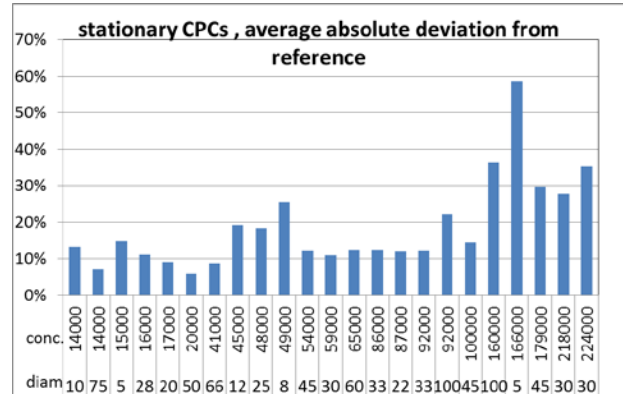


Figure 2. Stationary CPCs, average deviation of 9 instrument types (17 specimens) from reference in dependence of concentration and particle diameter

The determination of hydrophobic DEHS aerosols (100 nm, 92 000 cm⁻³) revealed the expected difference between alcohol and water based CPCs of approximately 40 % deficiency for water based CPCs with the positive exception of a TSI 3788.

Conclusions for field use can be drawn as follows:

- An upper limit for the concentration and a lower limit for the particle diameter must be respected.
- Stationary CPCs show fewer problems with high concentrations and lower particle diameters.
- If the devices switch from single count mode to photometric mode the deviation from the reference concentration can increase dramatically.
- It was observed that individual maintenance/calibration issues are more important for the optimal performance of instruments than their "general properties".

The findings are included in a novel European standard EN 16897 for use of CPCs in workplace exposure determination.

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